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EXTENT AND AGE OF CAP-AU-GRES FAULT.

CHARLES KEYES.

On the general geological map of Iowa there are three peculiarities in the areal distribution of the geological formations represented which excite particular attention. They indicate that not only has the terranal story not been yet all told but that owing to unusual misinterpretation the real facts have been unwittingly greatly distorted. One of these features is the notable southeastward straight trend of the eastern border of the basal Missourian, or Bethany, limestone as it leaves our state in Wayne county—a direction nearly at right angles to that which we would ordinarily expect.

South of the Iowa boundary, in Missouri, the southeasterly trend of the Bethany escarpment is traceable for a distance of fully fifty miles. This basal Missourian limestone (Upper Coal Measures) is found to extend in a long tongue, cut through at several points by the present streams. Beyond, the trend of the Bethany ridge assumes its normal course, that is, southwestward, and reaches Kansas City and far to the south finally enters Oklahoma.

Twenty years ago, when I was in charge of the Missouri Geological Survey, I discovered the existence of and mapped rather carefully this singular eastwardly projecting tongue of the Bethany limestone. At that time I did not fully understand the real significance of the phenomenon. Recently, in the course of professional duties, I found out the cause. Called upon to "match up," as it were, the coal seams of a number of localities rather widely separated from one another and irregularly scattered through several counties along the Iowa-Missouri boundary-line, so that diamond-drill prospecting could go on under check, I spent several days before I came to realize what the trouble actually was. In former years whenever I came across some puzzling problem I could, so soon as it failed to yield a quick solution, and before I tired, drop it instanter and turn to some more tractable topic. Now, I had either to find a satisfactory answer or admit failure which would spell disaster professionally. Moreover, it was a time when results had to be

measured in dollars and cents. The process required the same nicety of calculation, but with more variable factors, as when Leverrier figured out for the first time the position in the heavens of the then unknown planet Neptune.

In the region under consideration the general slope of the upland plains surface is eastward or southward; the general slant of the strata is to the westward. In other words the present peneplain bevels all the rock-layers between the Mississippi and Missouri rivers. It so happens that the coal seams of the region, in Appanoose and Wayne counties, in Iowa, and in Putnam, Mercer, Sullivan and Adair counties, Missouri, present greater individuality and cover wider areas than do the majority of the coal beds of the two states mentioned. With them also are associated several distinctive limestones which serve as guide-horizons.

The especial difficulty in attempting to decipher the detailed stratigraphy of this district is that it is deeply covered by glacial till, making outcrops of the Coal Measures few and far between. Upon first reentering the field it was inferred that the existence of the long tongue of Bethany limestone was due to the fact that it lay in a trough. This soon proved to be the case. The noteworthy feature about the trough was that it was plainly asymmetrical. To the northeast all the coal beds were found to rise steeply. There was apparently present a sharp monoclinal fold having its lower limb to the west. On the section between Princeton, Missouri, and Seymour, Iowa, there was an abrupt descent just out of Powersville of nearly 200 feet. On the line between Milan and Centerville there was, five or six miles southwest of Unionville, a similar abrupt descent. Between Milan and Kirksville like conditions and figures obtained.

In previous years it had been found that farther south or southeastward, near Macon, there existed what appeared to be a marked anticline, or perhaps monocline, in which the rock layers on one side sloped steeply to the northeast. Still farther to the southeast it had been noted that the coal-bearing strata were abruptly cut off from the Early Carbonic and other limestones along a rather sharply defined line running through Shelby, Monroe and Ralls counties. This phenomenon had never been satisfactorily explained.

When working in Missouri I had also taken occasion to trace the Cap-au-Grés fault, the features of which are so well displayed on the Mississippi river above the mouth of the Illinois river, from near Folley Station through Lincoln and Pike counties. Now all these apparent anomalies of which mention has been made lie in a slightly curved line extending from the mouth of the Illinois river to Leon, in Decatur county, Iowa. Indeed they prove to be expressions of some line of notable displacement rather than of a line of unusual flexing.

Eastward from the mouth of the Illinois river the fault-line passes through the city of Alton, the prominent bluff overlooking the town being in fact a fault-scarp. Although not yet actually traced on the ground beyond Alton the distribution of the coal mines and other features indicate in no unmistakable way that it extends far beyond. The line seems to pass about three miles north of Edwardsville, about twelve miles south of Vandalia, near Louisville, through Olney and Lawrenceville, at the southernmost end of the Illinois oil fields, to Vincennes, Indiana. Between Vandalia and the Indiana boundary the line is parallel to the anticlinal axis of the Oshawanee Hills, a marked structural range crossing southern Illinois and forming the eastward prolongation of the Ozark uplift of southern Missouri and northern Arkansas.

From Leon, Iowa, to Vincennes, Indiana, the distance is 400 miles. At the Mississippi river the difference in level of the same layers on the two sides of the fracture is more than 1,000 feet. The Cap-au-Grès fault is the most remarkable line of displacement in the entire Mississippi valley. At the Sandstone Headland the movement is probable near maximum. Towards either end the amount of displacement becomes gradually less and less until finally in north Missouri and southern Iowa there is no fracturing of the rocks at all, the vertical movement finding expression in a sharp monoclinal fold.

The typical structural features of this great line of displacement as exposed at the Cap-au-Grès on the Mississippi river, I have already described.[1] Near the fault the rocks are upturned so that in a distance of about one mile along the river almost the entire Paleozoic section from the Cambric to the Carbonic

[1]Proc. Iowa Acad. Sci., Vol. V, p. 58, 1898.

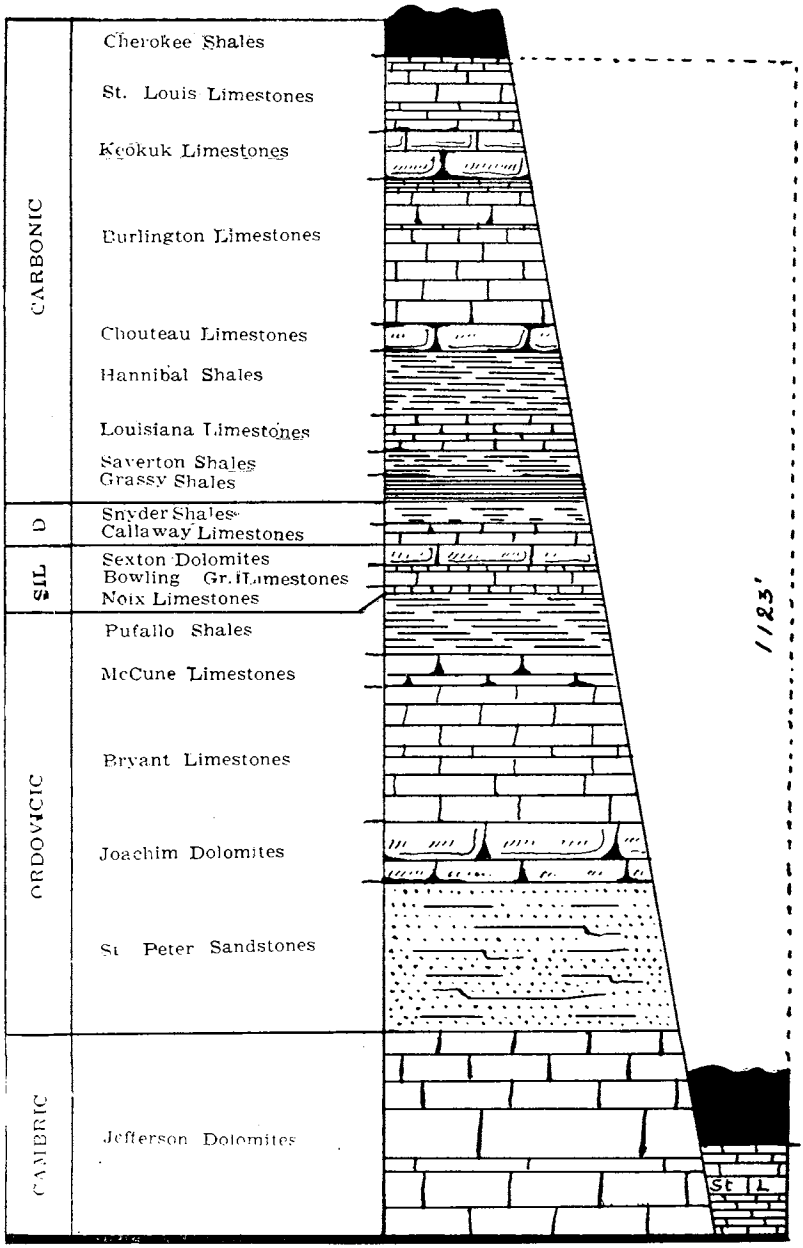
terranes is fully represented and is in sight at one time. I recall no other instance of the kind on the whole continent.

The magnitude of the displacement is best shown in diagram (Plate III) in which the distance between the two parts of the Coal Measures is indicated to be approximately 1,123 feet. This figure does not represent the total movement. It is only the actual vertical movement. The lateral movement is doubtless much more; how much it is not possible at the present time to state. In the case of the crustal rupture producing the San Francisco earthquake a decade ago the maximum vertical translocation was about four feet, while the horizontal component was more than twice this amount. Perhaps about this ratio obtains in the Cap-au-Grès instance.

One of the remarkable features of this fault is the tremendous extent of the "drag." In the west bluff of the Mississippi river this is shown to be not less than 300 feet. Many faults of greater throw do not display any appreciable drag.

This recognition of the wide extent of the Cap-au-Grès displacement has a profound effect upon the general mapping of the states through which the line passes. A broad belt reaching east and west entirely across the state of Illinois now sorely needs notable rectification of all of the formational boundaries. A similar wide belt traversing the state of Missouri also requires complete readjustment of the control on the areal distribution of the rock terranes. In Iowa, where far less mapping was done in the office and where the field work was more painstaking, the published maps demand no material revision. It is singular that in the other states so conspicuous a feature should be so long so completely overlooked, especially since the cue is so plainly given. It is instructive in this connection to peruse the field notes of J. A. Udden[2] on the tracing of the Shoal Limestone in western Illinois. After following the outcrops of the formation southward entirely across Macoupin county he suddenly loses all signs of them; and they do not reappear to him until he reaches the south edge of Madison county, fifteen or twenty miles away. Now this interval where he is unable to detect the Shoal rock is right in the great fault belt and the limestone no doubt lies several hundred feet beneath the surface of the ground. If at the last point of ex-

[2]Illinois Geol. Survey, Bull. 8, p. 120, 1907.



Magnitude of the Cap-au-Grés fault.

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posure in Macoupin county Udden had sharply veered to the eastward towards Greenville and Vandalia he might have found abundant outcrops extending that far beyond his last. On the other hand had he traveled southwestward he might have caught up the outcrop again running from a point east of Alton southeastward to the south line of Madison county where he actually did pick up the thread again. This belt of country extending from Alton eastward well merits close inspection anew.

The period at which this great rent in the earth's crust took place is a matter of some moment. That it was subsequent to the close of the Paleozoic era is clearly indicated by the fact that the Coal Measures are fully involved and abut Cambric sandstones. That it probably was closely associated with the uplifting of the Ozark dome is shown by the circumstance that it is parallel to and near the margin of the broad arch; in fact it seems as if the movement were a part of the same orographic disturbance which involved the Ozarks but that the great arch was not able fully to sustain itself on the north and dropped. The Early Tertiaric peneplanation of the region effects both the Ozark surface and the region covering the fault area. The faulting thus doubtless took place about the beginning of Tertiaric time.

DES MOINES.